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Erosion and Sedimentation Analysis of Rural Channels (RC) and Main Drainage Channels (MDC) on Tidal Lowland in Indonesia

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Abstract:- The purpose of this study is to conducting a field study by surveying and investigating the Rural Channel (RC) and Main Drainage Channel (MDC) and to analyzing the grainsize diameter in the P8-13S scheme, an accumulation of sediment transport in the channel is found, namely erosion occurring in the Rural Channel (RC) and Main Drainage Channel (MDC).

The location of research is reclaimed tidal delta region Telang I representing land typology A/B and the survey was conducted at 13 South Secondary Primary 8 scheme on tertiary channels.

The results study was After conducting a field study by surveying and investigating the Rural Channel (RC) and Main Drainage Channel (MDC) and analyzing the grain size diameter in the P8-13S scheme, an accumulation of sediment transport in the channel is found, namely erosion occurring in the Rural Channel (RC) and Main Drainage Channel (MDC) on average ranging from 3,301,859 m^3-3,349,103 m^3 while the average sedimentation ranged from 809,232 m^3-898,467 m^3.

Keywords:- *Rural Channel; Main Drainage Channel; Erosion; Sedimentation.*

I. INTRODUCTION

Indonesia has the potential land for agriculture area of approximately 162.4 million ha, most of the potential land consists of swamp areas covering 33 393 million ha, divided into 20 097 million ha of tidal marsh and 13 296 million ha of lowland swamp scattered on the island of Sumatra, covering 9:37 million ha, Kalimantan area of 11,707 million hectares, an area of 1,793 million ha Sulawesi and Papua, an area of 10,522 million ha.

Swampy area that has been reclaimed by the government has reached 1.8 million ha by the private and public sectors around 2.1 million hectares for a total of 3.9 million hectares, but land productivity achieved is still low at an average of 3 tons/ha [1].

Study of data inventory of swamp areas in the western and eastern regions, concludes that from the total area of swamps that have been reclaimed 1.8 million ha, there are 0.8 million ha of abandoned or abandoned swamps. Neglected land is caused by various things, including the existing water system is less than optimal, because the existing flow system is not appropriate. In addition, the condition of water channels and water structures has also not been rehabilitated for a long time, plus the maintenance of channels is not optimalyet[2].

Also note that the tidal swamp area is generally an area that has a relatively flat topography, is located near the beach in a river mouth and is naturally formed which is also affected by periodic tides. The characteristics of tidal swamp areas are very unique when compared to technical irrigation areas because tidal swamp areas have their water supply always supplied from tides and tides. The condition of the soil has a characteristic that is acidic, contains pyrite, peat and is found in salt water intrusion during the dry season [3].

Changes in water level in swamps in tertiary plots and canals are greatly influenced by several conditions, including: the amount of rainfall, land hydro-topography, potential for tidal overflows, potential for drainage, condition of water systems, and operation of water structures. For this reason, all components must be evaluated and analyzed to support efforts to meet the needs of plant water. In the channel itself, observation data is needed directly in the field so that accurate observational data can be obtained. But this way requires considerable time, effort and cost. Therefore the use of computer models to predict and evaluate network performance especially channel conditions is an appropriate solution [4].

Surface water control in course of swamp reclamation is key process that must be done well andtrue. In this hook, the swamp reclamation should use concept "shallow-intensive drainage" and not "intensive-deep drainage". Second this concept is properlycombining with exile control and water restraint [5]. but such followSuryadi (1998), when connecting with water management and design criteria can be done with twoapproach, that is minimum reclamation (minimum disturbance), and reclamation total (maximumdisturbance). For condition in Indonesia, approaching minimum disturbance still best [6].

II. MATERIAL AND METHODS

This research was conducted in the delta region Telang I, which is a swampy area in the province of South Sumatra, also reclaimed the second generation following the double-grid design layout (Rib System) along with Telang II, Delta Saleh and Sugihan [7].

The next design for an open channel system is prepared by the Institute of Technology Bandung (ITB). The system consists of a main line (also used for navigation), secondary channels and tertiary channels. Figure 1. Map of the research location.

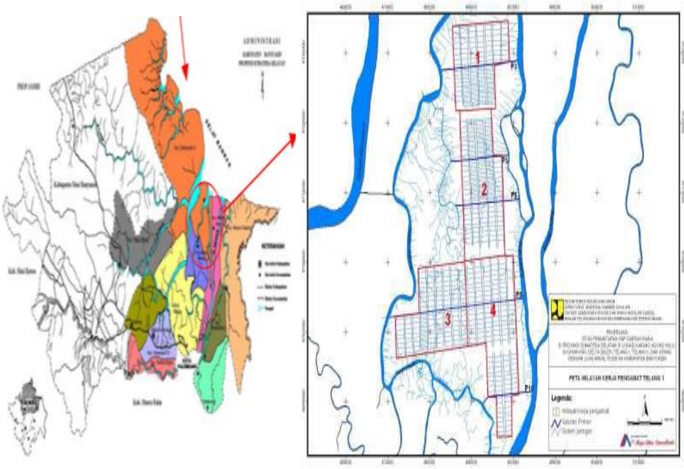
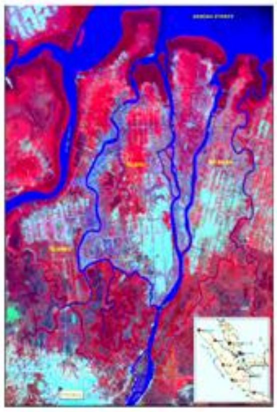


Fig. 1: Research location

Geographically, the region Telang I is located at 02^0 29'to 02^0 48' latitude and 104^0 30' until 104^0 52' East Longitude. Generally, Telang I is located in the north bordering the Strait of Bangka, south bordering the river by contrast, the east with the Musi river and the west bordering the Telang I river (Figure 2).

Hydrologically, Telang I area is an area surrounded by tidal rivers. Region east with the Musi river, the west bordering the Telang river, Bangka Strait in the south and the north is bordered by the river by contrast.

Figure 3 shows the layout of the hydro-topographic conditions in the area Telang I. Hydrology of the block is determined by adjacent channel conditions, the status of water in each channel, the operation of the door, the influence of the tides, and the climatic conditions such as rainfall and evapo-transpiration [7].



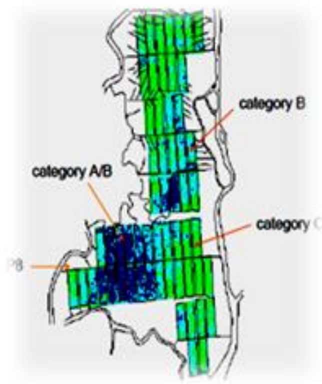


Fig. 2. And Fig. 3. Geographic location and Hydro-topograpic conditions of delta Telang I

Research Tools that will be used in this research are as shown in Table 1.

No.	Tools	Unit	Uses
1	Stationery	2 pieces	Data recording results
2	Computer (RAM 2 GB)	1 unit	Perform general modeling
3	Printer	1 unit	Displaying writing in the report form
4	MS-Excel,	1 pieces	To perform modeling and data processing
5	Laptop	1 pieces	Assist to make report
6	Sieve Analysis ● Oven ● Digital scales	1 pieces	Determine the diameter of granular material

Table 1: List of Tools Used in the study

III. RESULTS AND DISCUSSION

A. Characteristic of Sediment Grains

The basic material of the channel taken from the Rural Channel (RC) and Main Drainage Channel (MDC) Soil Mechanics Laboratory with the aim of determining the type of dominant sediment material contained in the RC and MDC secondary channels. This analysis stage includes sampling of disturbed samples, namely material in the channel and sieve analysis test. The sieve analysis results are as in Table 2.

Sieve Size		**Individual Mass Retained**	**Cumulative Mass Retained**	**Percent Retained**	**Calculated Percent Passing**
(Inch)	(mm)	(gram)	(gram)	(%)	(%)
No. 4	4.75	20.25	25.00	3.27	41.43
No. 8	2.38	25.30	50.30	1.71	39.72
No. 10	2.00	27.55	77.85	1.86	37.86
No. 16	1.18	40.03	117.88	2.70	35.15
No. 20	0.84	48.75	166.63	3.29	31.86
No. 30	0.59	59.12	225.75	3.99	27.86
No. 40	0.425	70.20	295.95	4.74	23.11
No. 50	0.297	79.00	374.95	5.34	17.77
No. 80	0.212	82.99	457.94	5.61	12.16
No. 100	0.149	86.00	543.94	5.81	6.35
No. 200	0.05	93.88	637.82	6.34	0.00

Table 2: The Sieve Analysis of the sample in rural channel (rc)

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From Table 2 is obtained cumulative passing percent (% pass) from the analysis of the sediment grain size in the channel by dividing the sieve size that are small, medium or large. The results of the analysis show that filter No. 4 produces a percentage of passing 41.43% and filter No. 100 has a percentage of passing 6.35%. To get the grain diameter measurement results of the sieve analysis, it is illustrated in the log graph of the distribution of grain diameters for each channel both in the Rural Channel (RC) and in the Main Drainage Channel (MDC).The graph of the depiction of the grain size distribution is given in Figure 4.

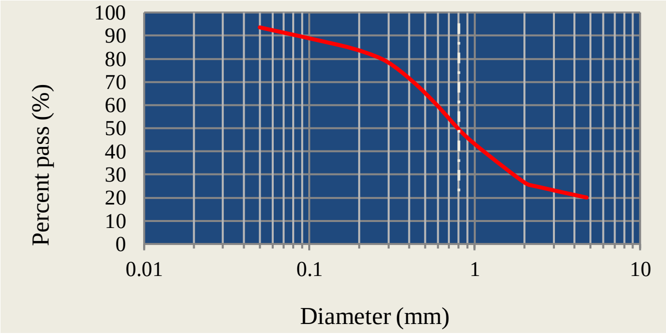

Fig. 4: Grain size distribution chart of Rural Channel

From Figure 4 is obtained d_{35}, d_{50} and d_{90} granular diameters, with the respective values of d_{35} (granules with percent pass filter up to 35% are 1.50 mm); d_{50} (granules with percent pass filter up to 50% are 0.80 mm) and d_{90} (granules with percent pass filter up to 90% are 0.08 mm). The size of the granules with a certain diameter is needed to classify whether the granules in the Rural Channel (RC) and Main Drainage Channel (MDC) include cohesive or non-cohesive sediment grains such as the discussion of cohesiveness of sediment material [8].

B. Cohesiveness of Sediment Materials

Sediment particles that are smaller than 2 µm (clay) are generally considered cohesive sediments. Coarse sediments larger than 60 µm are non-cohesive sediments. Whereas Mud (Silt), whose size is (2 µm - 60 µm) is considered to be between cohesive and non-cohesive sediments [9]. From the grain distribution graph (Figure 4), the average diameter of sediment material in the Rural Channel (RC) is 0.797 mm > 0.060 mm, meaning that the grain size in the Rural Channel (RC) is non-cohesive sediment. While the Main Drainage Channel (MDC), has an average diameter of 0.793 mm > 0.060 mm, also includes non-cohesive sediments [10].

The causes of erosion and sedimentation in the RC and MDC are more dominated by external factors such as currents that occur due to tides and waves due to ship movements in the secondary channel (RC and MDC) while internal factors (velocity and tidal movement) do not have much influence channel erosion and sedimentation.

C. Survey and Measurement of RC and MDC Profiles Cohesiveness of Sediment Materials

Rural Channel (RC) survey and measurements were carried out to obtain longitudinal and transverse profiles. For cross sections of the Main Drainage Channel (MDC) as shown in Figure 5, Figure 6 and Figure 7.

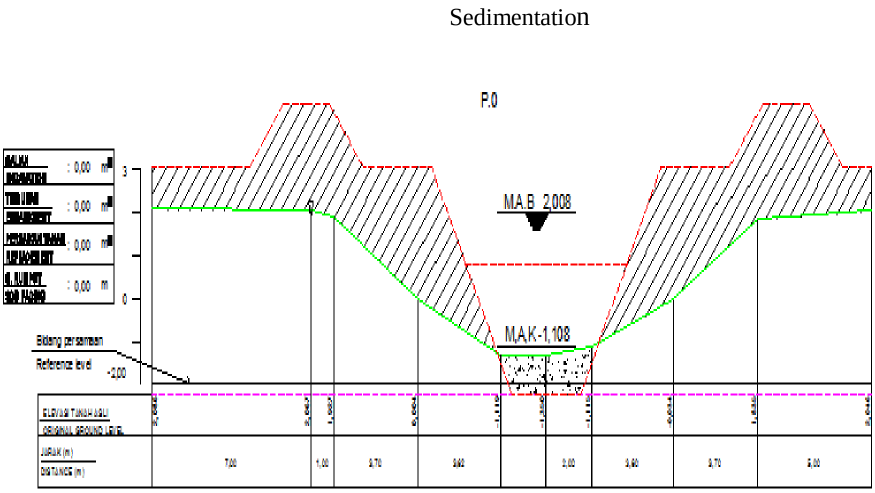

Fig. 5. Cross profile of Rural Channel (RC) on section P_0

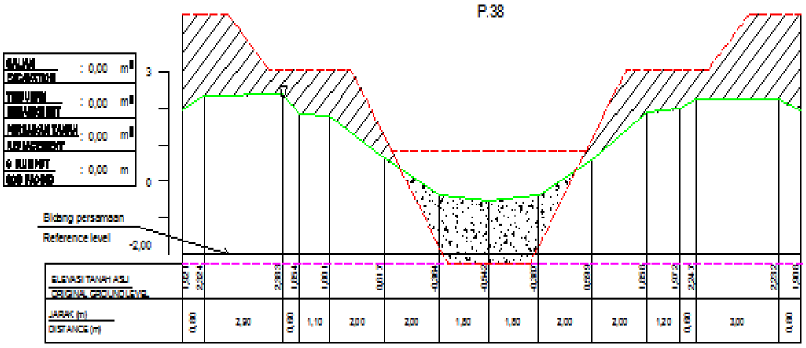

Fig. 6: Cross profile of Main Drainage Channel (MDC) on section P_{38}

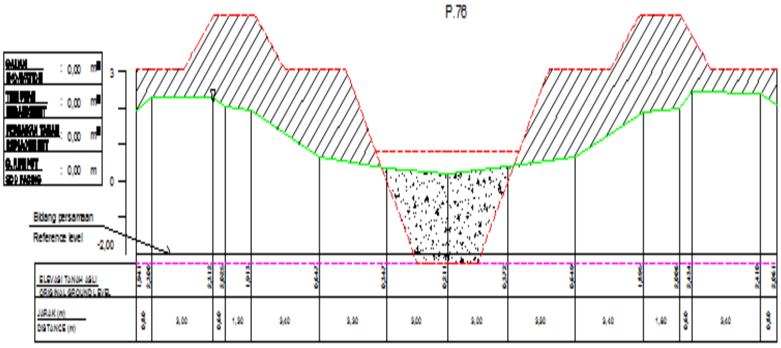

Fig. 7: Cross profile of Rural Channel (RC) on section P_{76}

Based on Figure5, Figure 6 and Figure 7, the erosion that occurred in the Rural Channel (RC) at the cross section of the P_0 cross section at the point + 0.00 (at the beginning of the channel) amounted to 46,814 m^3. At section P_{38} (cross section at the centre of the channel) at a distance of 1,500 m from the beginning of the channel, erosion occurred at 26,360 m^3 and at section P_{76} (cross section at the end of the channel) at a distance of 3,800 m from the channel starting point, an erosion of 41,476 m^3. Cumulatively, the average erosion that occurs in the Rural Channel (RC) along the 3,800 m is 33,019 m^3.

Sedimentation that occurred in the Rural Channel (RC) on the cross section P_0 cross section at the point of 0.00 (at the beginning of the channel) was 6.150 m^3. At section P_{38} (cross section at the centre of the channel) at a distance of 1,500 m from the beginning of the channel, sedimentation occurred at 7565 m^3 and at section P_{76} (cross section at the end of the channel) at a distance of 3,800 m from the channel starting point, sedimentation occurred at 11,685 m^3. Cumulatively, the average sedimentation that occurs in the SPD channel along the 3,800 m is 8092 m^3.

The survey results and Main Drainage Channel (MDC) measurements in the P8-13S scheme show patterns of erosion and sedimentation. The results are drawn cross sections as in Figure 8, Figure 9 and Figure 10.

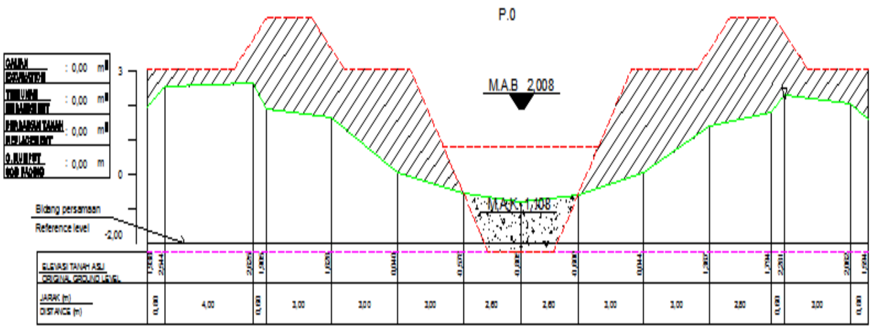

Fig. 8. Transverse profile of Main Drainage Channel (MDC) on section Po

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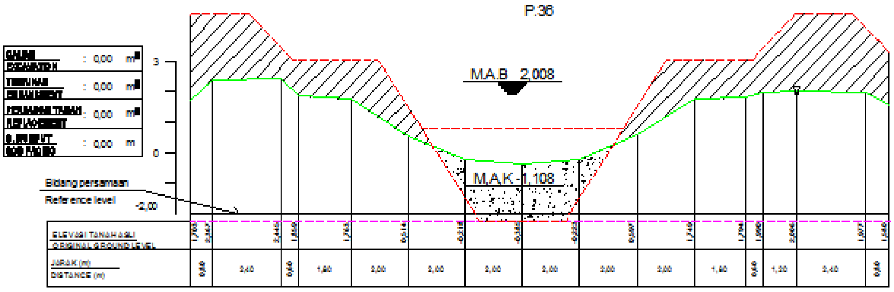

Fig. 9. Transverse profile of Main Drainage Channel (MDC) on section P_{36}

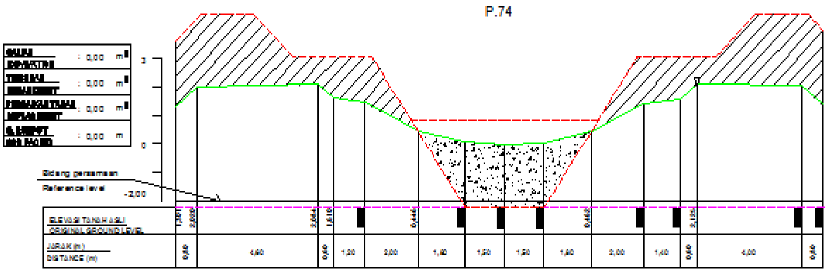

Fig. 10. Transverse profile of Main Drainage Channel (MDC) on section P_{74}

From the Figure 8, Figure 9 and Figure 10, the magnitude of erosion that occurred in the Main Drainage Channel (MDC) at the cross section of P_0 crossed at + 0.00 (at the beginning of the channel) was 4,857,000 m^3. In section P_{36} (cross section at the centre of the channel) at a distance of 1,500 m from the start of the channel, erosion occurred at 3,175,000 m^3 and at section P_{76} (cross section at the end of the channel) ie at a distance of 3,800 m from the channel starting point, erosion occurred amounting to 2,946,000 m^3. Cumulatively, the average erosion that occurred in the Main Drainage Channel (MDC) along the 3,800 m was 3,349,103 m^3.

Sedimentation that occurred in the Main Drainage Channel (MDC) at the cross section P_0 at the point +0.00 (at the beginning of the channel) was 574,000 m^3. At section P_{38} (cross section in the middle of the channel) at a distance of 1,500 m from the beginning of the channel, sedimentation occurred at 792,000 m^3 and at section P_{76} (cross section at the end of the channel) at a distance of 3,800 m from the starting point of the channel, sedimentation occurred at 1,137 .000 m^3. Cumulatively, the average sedimentation that occurred in the Rural Channel (RC) along the 3,800 m was 898,467 m^3.

D. Erosion and Sedimentation Patterns in Rural Channel (RC)

The results of surveys and measurements carried out along the 3900 m, obtained erosion patterns forming a semi logarithmic curve as shown in Figure11. the erosion pattern is obtained in the Main Drainage Channel (MDC) where at the starting point (downstream of the channel) forms a high erosion pattern then in the middle of the channel has a low pattern and towards the upstream the channel forms an enlarged pattern again. This can be interpreted that the erosion that occurs in the Rural Channel (RC) is caused because at the beginning of the channel occurs at accelerating flow and the more in the middle of the channel has a relatively constant velocity then there will be an accelerated flow to the end of the channel (upstream of the channel) and an average erosion value of 3,301,859 m^3.

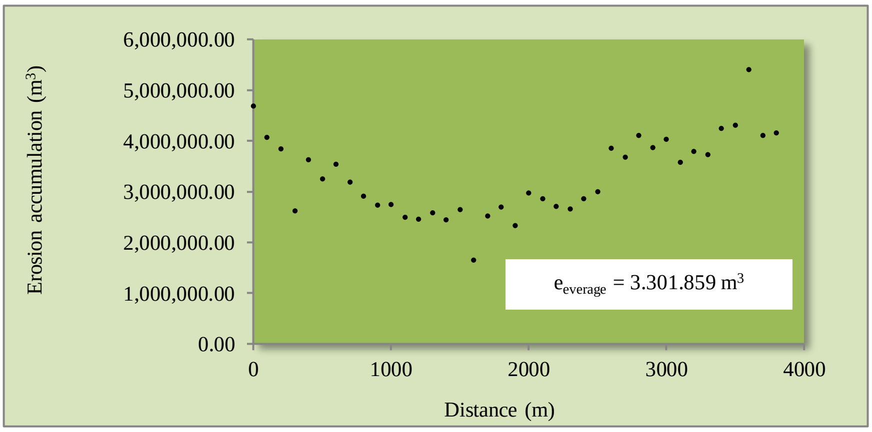

Fig. 11: Erosion accumulation in the Rural Channel (RC)

Rural Channel (RC) sedimentation patterns as shown in Figure 12. Shows at the beginning of the channel a small sedimentation pattern then enlarges upstream to the end of the channel. This is because the Rural Channel (RC) secondary channel in P8-13S is broken at the end of the channel, meaning that the channel is not translucent at the end of the channel. At the beginning of the channel, less sediment enters and then a build up of suspended material occurs in one third of the channel and subsequently the sedimentation is constant. The sedimentation value in the Rural Channel (RC) is an average of 809,232 m^3.

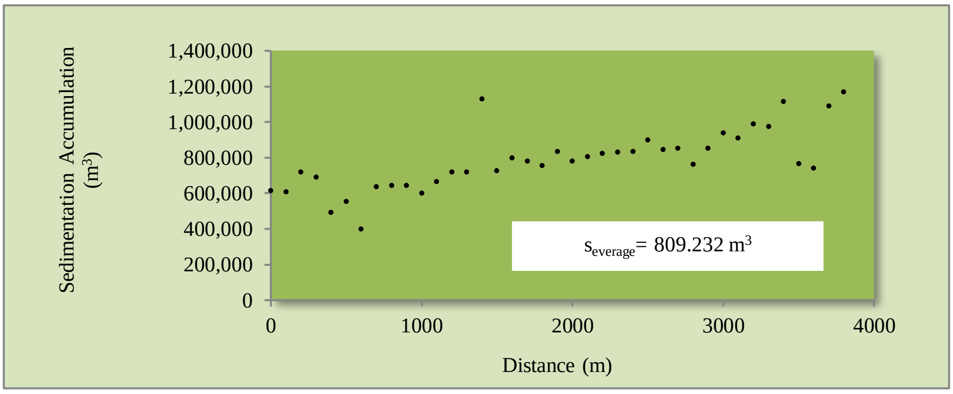

Fig. 12: Accumulation of sedimentation in the Rural Channel (RC)

The survey results and Main Drainage Channel (MDC) measurements obtained erosion and sedimentation patterns as shown in Figure 13 below, where the erosion patterns in the Main Drainage Channel (MDC) have a small pattern at the beginning of the channel to the end of the channel along the 3,800 m. This erosion pattern is caused because when the water in the paddy field or from the tertiary canal is drained, there is accumulation of flow from the Main Drainage Channel (MDC) itself or from the tertiary channel. Whereas at the distance further upstream of the Main Drainage Channel (MDC), the flow from the tertiary plots has decreased, reducing the flow capacity so that the velocity also decreases with an average erosion of 3,349,103 m^3.

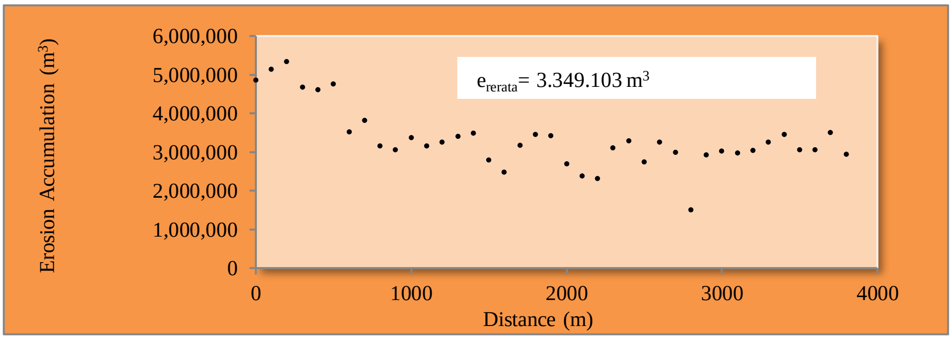

Fig. 13. Erosion Accumulation on Main Drainage Channel (MDC)

For Main Drainage Channel (MDC) sedimentation values have the opposite trend of erosion patterns that occur as shown in Figure 14. Shows the pattern of sedimentation in the beginning (upstream channel) has a low pattern and increasingly upstream has increased sedimentation accumulation. This is possible because when the water in the tertiary plot is drained, the tertiary channel at the beginning of the Main Drainage Channel (MDC) has a small flow in the last channel and increasingly towards the beginning of the channel the flow capacity is quite large because there is still a flow in the tertiary plot that is drive the flow in the initial tertiary plot. The Sedimentation value in the Main Drainage Channel (MDC) is an average of 898,467 m^3.

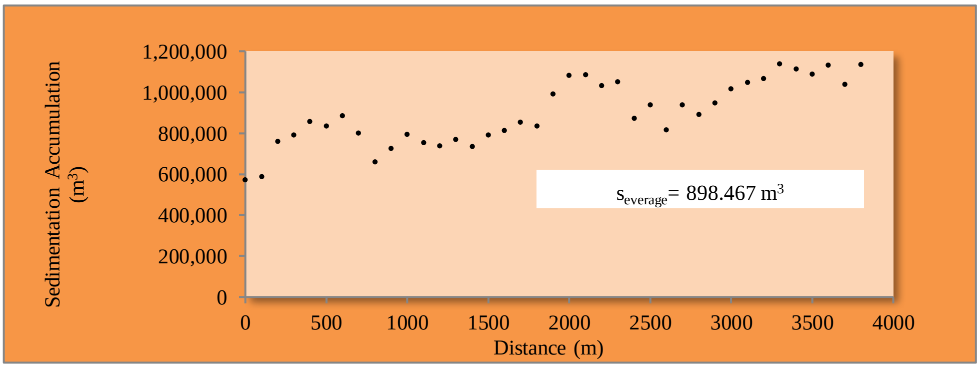

Fig. 14: Accumulation of sedimentation in the Main Drainage Channel (MDC)

IV. CONCLUSSION

From this study the following results were obtained: After conducting a field study by surveying and investigating the Rural Channel (RC) and Main Drainage Channels (MDC) and analyzing the grain diameter in the P8-13S scheme, an accumulation of sediment transport in the channel is found, namely erosion occurring in the Rural Channel (RC) and Main Drainage Channel (MDC) on average ranging from 3,301,859 m^3-3,349 ,103 m^3 while the average sedimentation ranged from 809,232 m^3 - 898,467 m^3.

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